

CLAIMS

What is claimed is:

1. A method for enzymatically degrading lignocellulose comprising the steps of:
  - 5 (a) subjecting an aqueous mixture containing lignocellulose with ultrasound; and
  - (b) contacting the mixture with a cellulase under conditions sufficient for hydrolysis.
- 10 2. The method according to Claim 1 wherein said aqueous mixture of step (a) further comprises said cellulase.
3. The method according to Claim 2 wherein said cellulase is provided by a cellulase-producing microorganism in said aqueous mixture.
- 15 4. The method according to Claim 2 wherein said step (a) is continuous.
5. The method according to Claim 2 wherein said step (a) is discontinuous.
6. The method according to Claim 1 wherein said ultrasound is conducted at a frequency of between  
20 about 2 and 200 kHz.
7. A method for enzymatically degrading lignocellulose comprising the steps of:
  - 25 (a) subjecting an aqueous mixture containing lignocellulose with ultrasound; and
  - (b) contacting the mixture with a cellulase and ethanologenic microorganism under conditions sufficient for hydrolysis.

8. The method according to Claim 7 wherein said aqueous mixture of step (a) further comprises said cellulase and ethanologenic microorganism.
- 5 9. The method according to Claim 8 wherein said cellulase is provided by a cellulase-producing microorganism in said aqueous mixture.
10. The method according to Claim 8 wherein said step (a) is continuous.
- 10 11. The method according to Claim 8 wherein said step (a) is discontinuous.
12. The method according to Claim 8 wherein said ultrasound is conducted at a frequency of between about 2 and 200 kHz.
- 15 13. The method according to Claim 8 wherein said ethanologenic microorganism is an ethanologenic bacteria or yeast.
14. The method according to Claim 13 wherein said ethanologenic microorganism is a bacteria or yeast which expresses one or more enzymes which,  
20 individually or together, convert a sugar to ethanol.
15. The method according to Claim 13 wherein said ethanologenic microorganism expresses enzymes which, individually or together, convert pentose and hexose to ethanol.
- 25 16. The method according to Claim 13 wherein said ethanologenic microorganism expresses alcohol dehydrogenase and pyruvate decarboxylase.

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17. The method according to Claim 16 wherein said alcohol dehydrogenase and pyruvate decarboxylase are from *Zymomonas mobilis*.
18. The method according to Claim 13 wherein said  
5 ethanologenic microorganism expresses xylose isomerase, xylulokinase, transaldolase, and transketolase.
19. The method according to Claim 18 wherein said xylose  
10 isomerase, xylulokinase, transaldolase, and transketolase are from *Escherichia coli*.
20. The method according to Claim 18 wherein said xylose isomerase, xylulokinase, transaldolase, and transketolase are from *Klebsiella oxytoca*.
21. The method according to Claim 18 wherein said xylose  
15 isomerase, xylulokinase, transaldolase, and transketolase are from *Erwinia* species.
22. The method according to Claim 13 wherein said  
20 ethanologenic microorganism expresses alcohol dehydrogenase, pyruvate decarboxylase, xylose isomerase, xylulokinase, transaldolase, and transketolase.
23. The method according to Claim 22 wherein said  
25 ethanologenic microorganism is a recombinant microorganism expressing *Zymomonas mobilis* alcohol dehydrogenase and pyruvate decarboxylase wherein said microorganism is selected from the group consisting of *Escherichia coli*, *Klebsiella oxytoca*, and *Erwinia* species.

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24. The method according to Claim 23 wherein said ethanologenic microorganism is *Klebsiella oxytoca* P2.
25. The method according to Claim 23, wherein said ethanologenic microorganism is *Escherichia coli* K011.

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